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ABSTRACT

As a consequence of a validation study based on over 200 skilled technicians employed in engine manufacturing, seven aptitude tests were administered to 50 applicants in June 1982. This report presents correlations between test scores and three criteria (math grades, job performance ratings, and a composite) for the 26 people who entered the program. Math grades and the composite were well predicted by the aptitude tests, particularly the spatial ability, figural reasoning, and numerical reasoning tests. (Author/PN)

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ONE-YEAR FOLLOW-UP OF APPRENTICES IN A SKILLED-TRADES PROGRAM

by
Mark Daniel

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HUMAN ENGINEERING LABORATORY

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One-Year Follow-Up of Apprentices in a Skilled-Trades Program

by Mark Daniel

Abstract: This is a continuation of the validation research described in Technical Report 1982-5, "The relationship of aptitudes to the performance of skilled technical jobs in engine manufacturing." As a consequence of that research, the engine company administered seven aptitude tests to fifty applicants in June, 1982. The present report gives correlations between test scores and three criteria (math grades, job performance ratings, and a composite) for the 26 people who entered the program. Math grades and the composite are well predicted by the aptitude tests, particularly the spatial ability, figural reasoning, and numerical reasoning tests.

Introduction

In 1981-82, the Johnson O'Connor Research Foundation, with the assistance of Dr. Joel Wiesen of Applied Personnel Research Inc., conducted a validation study based on over 200 skilled technicians employed in the research and engineering section of a large manufacturer of diesel engines (Daniel, Wiesen, Trafton, and Bowker, 1982). The study indicated that tests of a variety of aptitudes correlated moderately highly with supervisors' ratings of cognitive aspects of job performance. The manufacturing company used these results to assemble a selection battery of seven aptitude tests, and administered the battery in June 1982, to fifty applicants for openings in the skilled trades training program.

The tests in the selection battery measure the following aptitudes: spatial visualization (test labeled SV-BC in the technical report on the validation study), figural reasoning (I-Fig), numerical reasoning (I-Num), numerical ability (Num), reading comprehension (Read), clerical speed (Cler), and manual dexterity (Place). Using the data from the validation study, the company established a multiple cut-off selection procedure: applicants had to score above the fifth percentiles of the incumbents' score distributions on the spatial visualization and reading comprehension tests (raw scores of 13 and 21, respectively) and above the fifth percentile on a composite score derived from the other five tests. The standardized beta weights used in forming the composite score are: figural reasoning, .206; manual dexterity, .132; clerical speed, .107; numerical ability, .101; and numerical reasoning, .070.

Because the cut-off scores were set fairly low, 41 of the 50 applicants passed the selection battery. Thus, there is a wide range of test scores among those who passed. Twenty-six of these applicants entered the skilled-trades training program. The other fifteen passing applicants either chose not to enter the program, or did not have sufficient seniority with the company to qualify (all applicants had been employed elsewhere in the company).

The skilled-trades training program is a four-year program combining on-the-job training with college coursework. Apprentices work the normal forty-hour work week under the guidance of journeymen, and take courses at a nearby university after working hours. Each apprentice is trained in one of four areas: mechanical work, instrumentation, chemical/polymer work, or metallurgical work.

Performance criteria

One criterion used in this study is the grade in the first mathematics course taken. During the first semester all apprentices take one of two math courses, either a course in second-year high school algebra or a college-level course in algebra and trigonometry. The university assigns apprentices to one of the two math courses by means of a placement test. Because a number of the apprentices failed the first-semester math course and had to repeat it in the second semester, whereas others took a more advanced math course in the second semester, it is felt that second-semester math grades do not form a useful criterion. The fact that different apprentices take different math courses in the first semester may tend to attenuate the prediction of math grades from aptitude test scores, because the more able students will have encountered more difficult coursework.

The second criterion is the supervisor's rating of job performance after six months on the job. Each apprentice was rated by one supervisor for overall performance on a four-point scale: "outstanding," "above average," "satisfactory" and "unsatisfactory." These ratings are not confidential ones collected for this follow-up study, as was the case in the original validation study; rather, they are the company's normal performance evaluations that go into the employees' personnel files.

The supervisors' ratings form a weak criterion in this particular study for two reasons. First, ratings from individual raters tend to be low in reliability. In the original validation study, we found that the average reliability of a supervisor's rating was .53 (Daniel et al., 1982). Raters may differ in the leniency of their ratings, and in the aspects of job performance they emphasize when making the overall ratings; their judgments may be influenced by personal like or dislike of the apprentice; and they may have different amounts or types of contact with the apprentice. The effects of these disturbing influences are reduced when each employee is rated by several supervisors. Second, the criterion used in the original validation study was a composite of ratings on several "cognitive" aspects of job performance, such as job knowledge, ability to learn, mechanical understanding, and mathematical and reading ability. Supervisors' ratings of "overall" job performance were found in the original study to reflect primarily the employees' reliability (dependability, quantity of work, initiative, etc.). The aptitude test scores were uncorrelated with these reliability ratings, and should not be expected to predict such ratings.

In summary, the supervisors' ratings of overall job performance are relatively unreliable measures of an aspect of job performance (dependability)

that the aptitude tests were not designed to predict. Nevertheless, because these ratings are the only available information about the apprentices' job performance, they will be analyzed in this follow-up study.

The correlations of the aptitude tests with both criteria will tend to be reduced by the fact that a number of apprentices dropped out of the program before obtaining first semester grades and/or performance ratings. It is reasonable to assume that those who withdrew for "personal" reasons were not, on average, well suited to the program. Although it is not possible to know whether these people would have failed the math course or earned "unsatisfactory" performance ratings, the fact that they left the program suggests that they experienced difficulty or dissatisfaction in one or both of these areas.

In order to incorporate these people into the validity analysis, a composite criterion of overall success in the program has been constructed. This index is the sum of standard scores on the two separate criteria (math grades and performance ratings). Seventeen of the apprentices have scores on both criteria. Among those who do not, four apprentices who withdrew for personal reasons and one who withdrew because of poor job performance have been assigned scores at the twelfth percentile of the distribution of composite scores for the seventeen with complete data. Four apprentices cannot be given scores on this composite: one who was on sick leave; one who retired, one who did not take either of the math courses, because he had taken a similar course previously; and one who withdrew from the first semester math course but is still in the program.

In conducting a predictive validation study such as this one, it is highly desirable to prevent the scores on the predictors (the aptitude tests) from influencing the judgments of the people giving performance ratings or course grades. It appears that such criterion contamination has been avoided in this research. The company filed the selection-test scores separately from the apprentices' basic personnel files, and supervisors have not had access to the test scores. The apprentices themselves have not been told their scores on the selection tests.

Results

Raw test scores and criterion data cannot be included in this report because it is possible that the apprentices could identify their own and one another's scores.

Grades in the first-semester math courses are available for nineteen apprentices. One apprentice did not take the course because he had previously passed a similar one. The other six did not complete the course: one withdrew without dropping out of the skilled-trades program, four withdrew from the overall program before finishing the course (one for retirement, two for personal reasons, and one because of poor job performance), and one was removed from the skilled-trades program because of poor academic performance. This last person has been assigned a course grade of F for purposes of this research, making a total of twenty apprentices with course grades.

The distributions of grades in the two math courses are shown in Table 1. It was previously mentioned that combining grades from two different courses into a single criterion might attenuate the relationship between aptitude test scores and grades. This attenuation effect is mitigated by the fact that the apprentices taking the more difficult course tended to obtain higher grades than those taking the easier course.

Job-performance ratings are available for nineteen of the apprentices. One apprentice who does not have a rating was on extended leave due to illness. The other six apprentices withdrew from the skilled-trades program before the end of six months, four for personal reasons, one for retirement, and one because of poor job performance. This last person has been assigned an "unsatisfactory" job rating for purposes of this research, giving a total of twenty apprentices with performance ratings. The distribution of ratings is shown in Table 2.

Table 3 shows the distribution of scores on the composite criterion, and Table 4 presents the correlations between the aptitude tests and the criteria. (The correlation between math grades and performance ratings for the seventeen apprentices having scores on both criteria is .59.) One-tailed tests of statistical significance are used in Table 4 because this is a confirmatory rather than an exploratory analysis. The purpose of this follow-up study is to see whether the results of the initial concurrent validation study, based on a far larger sample, are holding up in a predictive situation.

The mathematics-course grade is well predicted by the composite aptitude score and by five individual tests: spatial visualization, reading comprehension, figural reasoning, numerical reasoning, and numerical ability. It is noteworthy that the spatial and reading tests are not included in the composite, and so the validity coefficients for the spatial and reading tests and the composite are independent of one another. The predictive power of the composite aptitude score can be illustrated by comparing the ten apprentices scoring above 170 with the ten scoring at or below 169. Only one of the ten high-scoring apprentices failed the math course, whereas seven of the ten low-scorers failed. The average grade for the high scorers is B-, whereas the average for the low scorers is D.

None of the aptitude measures, including the composite score, has a statistically significant correlation with the supervisors' job-performance ratings. The highest correlations are for two of the tests that are good predictors of math grades, spatial visualization (.34) and figural reasoning (.25). As discussed previously, the aptitude test battery was not expected to predict supervisors' ratings of overall job performance.

The composite criterion, which reflects mathematics course performance, job performance rating, and status in the program (continuing vs. dropped out), is significantly correlated with the spatial visualization, figural reasoning, and numerical reasoning tests as well as with the composite aptitude score. These correlations support the inference, suggested by the correlations with the individual criteria, that spatial visualization ability and figural reasoning ability are especially important for success in the training program.

Table 1
Math Grades

Grade	Course level HS	College
A	0	3
B	3	3
C	3	0
D	0	0
F	4[a]	4
Total	10	10

[a] Includes one person removed for poor academic performance.

Table 2
Supervisor's Ratings

Rating	*N*
Outstanding	4
Above average	10
Satisfactory	4
Unsatisfactory	2*
Total	20

* Includes one who withdrew because of poor job performance.

Table 3
Composite Criterion[a]

Score	*N*	Score	*N*
14	1	7	4
13	2	6	0
12	2	5	0
11	0	4	7[b]
10	3	3	0
9	2	2	1
8	0		
		Total	22

[a] Sum of standard scores on math grade and supervisor's rating, subjected to a linear transformation and rounded off.

[b] Includes five who withdrew for personal reasons or poor performance.

Table 4
Correlations of Aptitude Tests with Criteria

Aptitude Test	Math Grade ($N = 20$)	Perf. Rating ($N = 20$)	Composite ($N = 22$)
Spatial visualization	.609**	.338	.600**
Figural reasoning	.456*	.245	.514**
Reading comprehension	.491**	.042	.338
Numerical ability	.427*	-.037	.342
Numerical reasoning	.443*	.157	.409*
Clerical speed	.192	-.061	.169
Manual dexterity	.218	.218	.335
Composite score	.624**	.167	.619**

**$p < .01$ *$p < .05$ (one-tailed tests)

Conclusion

Based on the data from the first twenty-six apprentices hired under the test-based selection system for the skilled-trades program, the aptitude tests are seen to be effective predictors of grades in the first mathematics course and of a composite criterion based on math grade, job-performance rating, and status in the program. The tests of spatial visualization, reading comprehension, figural reasoning, numerical reasoning, and numerical ability are most highly correlated with math grades; spatial visualization, figural reasoning, and numerical reasoning are also the best predictors of the overall criterion. The aptitude tests do not correlate significantly with supervisors' ratings of job performance; however, overall job ratings are known to reflect primarily the employees' dependability, and the aptitude tests are designed to predict more cognitive aspects of job performance.

Although this follow-up study is based on a small sample, its results are consistent with the findings of the original validation research. In particular, the predictive value of the figural reasoning test (the single best predictor in the original study) has been supported.

This is the first in what is planned as a series of follow-up studies of apprentices in the skilled-trades program. This first group of apprentices will be studied periodically, and new groups of apprentices will be added to the sample. It is hoped that in the future it will be possible to obtain more useful criterion data, in several ways: by providing a multi-scale performance-rating instrument covering both cognitive and noncognitive aspects of the job; by obtaining confidential ratings, used only for this research; by having more than one supervisor rate each apprentice; and/or by obtaining performance ratings for apprentices who withdraw or are removed from the program prior to the normal evaluation date.

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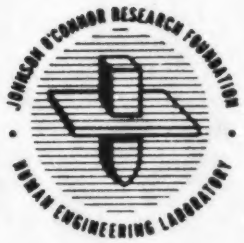
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